



Filling in the Gap

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The Cosmopolitan is being erected in a tight construction footprint in the heart of the Strip.

Who ever thought a small construction footprint would be an issue in Las Vegas? A new resort squeezes into a prime location on the Strip.

IN THE PAST 50 YEARS, LAS VEGAS HAS UNDERGONE SEVERAL TRANSFORMATIONS: FROM A SMALL GAMBLING TOWN TO A RISING GAMING DESTINATION TO THE GLOBAL ENTERTAINMENT CENTER IT IS TODAY. Each era has ushered in a dramatic shift in the Las Vegas cityscape—and with each shift comes demand for larger, more sophisticated buildings.

Las Vegas Boulevard—the Strip—has become a thoroughfare of desirable commercial and residential properties with tremendous investment potential. This transformation has resulted in a boom in high-rise construction that is, in effect, remaking the Vegas skyline. “Vegas lights” will have a new meaning, as the glitter from dozens of luxury residential towers begins to dominate the Strip.

Soon to make its contribution to these new Vegas lights is the Cosmopolitan Resort and Casino, which opens next year. Pioneering a new urban lifestyle, “Cosmo” is a high-density, ultra-compact, mixed-use development that combines sophisticated city living with all the amenities of a full-scale gaming resort. The Cosmopolitan brings to Las Vegas a pedestrian culture in which residents can take an elevator from their condominium unit to the theater, shops, and restaurants on the floors directly below.

Altogether, the final design packs nearly seven million sq. ft of functional space into a narrow (especially for Las Vegas) 8.5-acre lot. The Cosmopolitan will be comprised of two concrete towers rising from a six-story steel podium structure, which houses a five-acre pool deck, a 75,000-sq.-ft casino, a 150,000-sq.-ft convention



Steel shear walls are used for the lateral system of the Cosmopolitan's podium.

and meeting space, an 1,800-seat theater, a 50,000-sq.-ft spa and salon, and more than 300,000 sq. ft of entertainment space. Five basement levels beneath the podium will be used for underground parking.

Integrating Space and Accelerating Time

Integrating the components of this unique, urban residential development posed a number of engineering challenges that demanded daring and creative thinking. The foremost challenge was to create as much open and unobstructed space in the podium below the residential towers as

possible. The two towers are spread out over roughly 25% of the podium floor map. Since the towers use a typical concrete flat plate construction with columns and walls spaced anywhere from 18 ft, 6 in. to 30 ft apart, the columns and walls would have disrupted a considerable amount of convention, meeting, retail, and casino space where they run through the podium. Another significant challenge was to provide a structural solution that would be able to both shorten the complex construction schedule and meet the tight space requirements for the construction site.

As it turned out, the solution to these issues would invert a paradigm of engineering construction. Typical high-rise with podium construction usually involves a steel superstructure landing on a concrete podium or a steel podium built around the concrete high-rise structure. For the Cosmopolitan, a more audacious and inventive structural system was required to provide the space, flexibility, and savings in construction time that the owner, architect, and contractor were looking for.

The solution? A steel podium that supports the weight of two concrete towers, allowing for greater spans between columns. Since the structure encompassed every single square foot of the project site, construction access and sequencing made steel the favored choice at the podium and subterranean levels as well. Using steel, vertical construction sequencing was possible; three independent cranes were used simultaneously to accelerate the erection schedule and commence tower construction prior to podium completion.

A shear wall panel being installed.



The Two Towers

The Cosmopolitan's distinctive structural system is comprised of five major subsystems: the West Tower, East Tower, steel podium above grade, subterranean garage and foundation, and the faceted glass façade.

The East and West Tower—rising to 654 ft and 662 ft above street level, respectively—are each supported by a 6-ft concrete “sky mat” approximately 100 ft above grade, at podium levels four and five. All of the tower gravity columns and almost all but a few of the elevator core walls are terminated at the sky mat to create open spaces in the podium below. The sky mat was poured in three separate lifts above the podium deck. Each lift was designed to sustain the weight of the concrete already poured and the weight of the subsequent lift of wet concrete. Staging the concrete pour for the sky mat facilitated savings in steel framing and construction shoring.

The sky mat plays a central role in integrating the structural performance and behavior of the building. It serves to transfer the towers' gravity loads and overturning forces down to the foundation. The towers' shear forces are transferred out to the perimeter podium walls by a reinforced 12-in.-thick composite deck. A computer analysis was performed, modeling the gravity and lateral loads on the sky mat. Despite the large overturning moments, the sky mat study found that the supports always remained in compression. To provide this compressive capacity, large concrete-filled steel box columns are attached to the mat's underside. There are 75 box columns supporting the sky mat for the West Tower and 48 for the East Tower; they vary in dimensions from 3 ft to 4 ft.

Podium and Parking Garage

The steel podium's design was dictated by the architectural and functional need to provide unobstructed space. To achieve this, the podium's gravity system features heavy trusses, spanning approximately 150 ft, supporting 600 psf of built-up loading for the recreation deck and pools above. We selected steel shear walls as the lateral system for the podium. The walls were displaced to the perimeter of the podium to allow greater operational functionality and architectural flexibility within the podium structure. However, placing the walls adjacent to the property line caused tight site constraints. Close proximity of neighboring properties dictated the design consideration at some of the perimeter shear walls.

We anticipated these conditions and delivered a composite steel plate shear wall that can be erected with only near-side access and no forming demands on the far side.

The Cosmopolitan's steel-framed underground garage, having to provide enough space for 3,800 cars over a narrow plan, required one of the deepest digs in Las Vegas history. The contractor, Perini Building Company, spent 12 months excavating 800,000 cubic yards of sand and dirt to make room for a five-level parking structure and the foundation.

Curtain Wall

Serving as one of the main architectural attractions of this project, the faceted glass façade on Las Vegas Boulevard and East Harmon Avenue adds a cityscape element to the wide casino profile along the Strip. The geometry of the steel frames supporting the façade had to be stringently enforced and the tolerances tightly controlled in order to ensure the integrity of the large panes of glass encased within. We worked closely with the fabricator and designer to develop an intricate tube steel moment frame to meet the curtain wall's complex structural and architectural requirements.

Answering in Kind

Buildings that serve a novel use and employ innovative architectural layouts compel fresh and inventive designs. In taking on this project, we were able to uphold the bold vision the owner sought by integrating vertically what has in the past been developed horizontally. We did so by orchestrating a fusion of structural systems that defies convention and unequivocally answers the demands of a project that dares to create a way of life. **MSC**

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